

Active Harmonic Load-Pull using LSNA

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Abstract—An active harmonic load-pull setup using a LSNA is presented in this paper. This measurement setup opens up new possibilities in device characterization and power amplifier design.

I. MEASUREMENT SETUP

The harmonic load-pull setup is an active injection based setup. Therefore, no passive tuners are used which rely on pre performed tuner characterizations.

The heart of the setup is the large signal network analyzer (LSNA, Maury/NMDG MT4463). It allows waveform measurements up to 50 GHz for the highest harmonic. The LSNA is calibrated at the device under tests (DUT) reference plane and the output from the LSNA are the complex phasors a_1 , b_1 , a_2 and b_2 . The complete measurement setup is illustrated in Fig. 1.

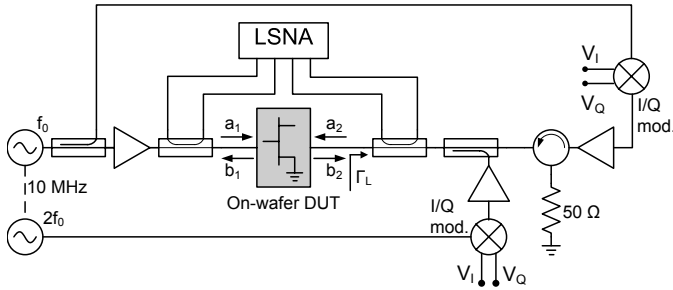


Fig. 1. The active injection based harmonic load-pull measurement setup.

Two synthesizers are used, one for the fundamental (f_0) and one for the second harmonic ($2f_0$). The fundamental controls both the input power and the load reflection coefficient (Γ_L). A circulator is used at the output of the DUT to separate the injected (a_2) and outgoing (b_2) wave, terminating b_2 in a 50 load. Γ_L seen by the DUT at f_0 is given by:

$$\Gamma(f_0) = \frac{a_2(f_0)}{b_2(f_0)} = \frac{A(V_I, V_Q)e^{j(\omega_0 + \theta(V_I, V_Q))}}{b_2(f_0)} \quad (1)$$

The amplitude (A) and phase (θ) of the injected a_2 wave are controlled with an I/Q modulator. The wanted Γ_L is obtained by choosing the correct values for the IQ-modulator control signals V_I and V_Q . These values are determined through an optimization procedure with a feedback through the computer controlling the measurement setup.

The Γ_L at $2f_0$ is synthesized in a similar way as for f_0 . The advantage with controlling the harmonic impedance is illustrated in Fig. 2 where the fundamental impedance is kept constant while varying the harmonic impedance.

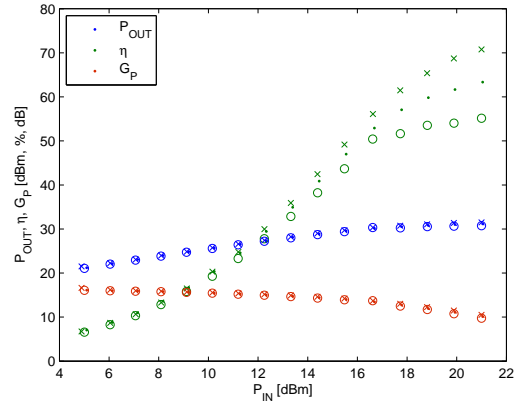


Fig. 2. The importance of taking the second harmonic into account. Optimum harmonic impedance (x), 50 Ω (.) and worst harmonic impedance (o).

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